

Control of Potato Diseases in Wisconsin

L. R. JONES



CLEAN SEED, CLEAN SOIL, CLEAN CROP

By planting clean seed upon clean soil Wisconsin farmers will be able to produce potatoes which will be in great demand not only for table use but also as seed for the growers of the states farther south.

AGRICULTURAL EXPERIMENT STATION
OF THE UNIVERSITY OF WISCONSIN

MADISON, WISCONSIN

DIGEST

As the potato is such an important cash and home-garden crop, it must be kept free from disease. Page 3

Wisconsin seed potatoes are now comparatively free from disease and must be kept so by careful spraying, rotation, and the use of healthy seed. Page 3

Potato leaves are attacked by a number of diseases. Spraying with Bordeaux mixture will largely control them, and the addition of either Paris green or lead arsenate to the mixture will kill the potato beetle. Pages 4-6

The tubers may carry disease either on the surface or internally. No tubers having discolored flesh should be planted. All that are not known to be free from disease should be dipped in solutions of formaldehyde or corrosive sublimate. Pages 6-16

New and dangerous diseases may be introduced on seed shipped from Europe, Canada, or the eastern part of the United States. Disinfect all such seed even though it appears perfectly smooth and healthy. Page 16

Empty potato warehouses may be disinfected by fumigation with formaldehyde, but the potatoes themselves are likely to be injured if fumigated. Page 17

The soil may harbor scab and other diseases, and no field on which potato scab has been serious should be planted to potatoes again for some five years.

Constant vigilance and cooperation of growers will be necessary to keep Wisconsin potatoes up to the highest standards for seed.

Control of Potato Diseases in Wisconsin

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INTRODUCTION

Clean seed, clean soil, clean crop, should be the motto of every Wisconsin potato grower. The potato is now one of Wisconsin's important cash crops and is destined to become even more so. While it is grown successfully everywhere, it is at its best in the newer lands of the central and northern sections, owing to the favorable combination of climate and soil conditions. At the outset, the crop in this new territory is comparatively free from disease. This not only insures the greatest yield with the least care, but it makes the crop from these lands of especial value for seed purposes.

The most serious potato diseases are introduced on the seed, but when once started, they may persist in the soil. It is therefore doubly important that the potato growers of these favored newer sections aim to use only seed which is free from disease. Thus they may secure the largest returns for the season, and at the same time, keep their soils from contamination and perpetuate the present reputation of Wisconsin-grown potatoes as exceptionally free from disease. This is of the greatest importance since the demand for Wisconsin potatoes to supply the southern seed trade is rapidly increasing.

The aim of this circular is to describe briefly some of the more important potato diseases and tell how to avoid and control them. It seems best to group them for this discussion according to their cause into:

1. Nonparasitic diseases caused by such injurious surroundings as unfavorable soils and moisture.
2. Parasitic diseases caused by specific parasites, bacterial, fungous, or insect.

¹ For colored illustrations of potato tuber diseases described in this bulletin see Wisconsin Poster Bulletin 1, issued June, 1914.

NONPARASITIC DISEASES

ARSENICAL POISONING

Symptoms.—Dying of the leaves, usually in spots, within a few days after applying Paris green or other arsenical poison.

Remedy.—Use poison more judiciously. If Paris green is used with water, add about one pound of lime for each pound of poison; if poison is applied dry, mix with air-slaked lime; if used with Bordeaux mixture there is no danger of injury.

SUN SCALD

Symptoms.—Wilting and burning of the tender young leaves in June and early July during very bright, hot weather; especially likely to occur after a period of warm cloudy weather. The youngest upper shoots suffer first and worst.

Remedy.—There is no remedy, and since the plants usually recover quickly, little permanent injury results.

TIP BURN

Symptoms.—During protracted dry hot weather in midsummer, the leaves weaken and die, beginning at their tips and margins. The older leaves and those on the lower part of the plants suffer first and worst. This is the commonest trouble in Wisconsin potato fields during midsummer, especially on the earlier potatoes. Anything that weakens the plants or injures the foliage increases this trouble.

Remedies.—Soil rich in humus, good surface cultivation to keep down weeds and check evaporation, spraying with Bordeaux mixture to keep the foliage healthy, late planting of early varieties.

LIGHTNING INJURY

Symptoms.—Sudden collapse and death of potato plants in a more or less circular spot in an otherwise healthy field. Such spots as we have seen have varied from a few feet to several rods in diameter, and in most cases the injury has occurred in the first half of July. In typical cases the main stems are at once blackened and killed for some distance above and below ground,



FIGURE 1.—TIP BURN OF POTATO

The leaves die, turn brown, and curl up beginning at the tips and margins. The commonest trouble in Wisconsin potato fields during dry, hot midsummer. Often mistaken for early blight.

but the fibrous roots, young tubers and upper leaves may not show injury until this results from the dying of the stem. These spots do not increase much in size and of course nothing can be done to lessen the injury after it has occurred.

LEAF ROLL

This has recently proved a serious trouble of potatoes in Colorado and some other western potato sections. In Wisconsin it occurs sparingly in some fields. It is characterized by a dwarfing and rolling of the leaves, beginning with the upper ones, accompanied by a change in color, in some cases to an unhealthy pale green, in others to reddish or purplish tints. The development of the plant is checked, the tuber yield from rolled plants is small and if such tubers are used for seed, they reproduce the disease. This is the most serious phase of the question since the Colorado growers or other users of Wisconsin seed stock wish seed free from this trouble. There is no parasite connected with the trouble and it does not spread from plant to plant. It is simply a degenerate condition of the affected plants. It is important, therefore, to eliminate such diseased or degenerate tubers from the seed stock. In order to do this, the grower should carefully go over all fields being grown for seed stock and "rogue" them, that is pull out all plants showing leaf roll. This can best be done about the blossoming stage, although it is better to go over the field a second time a week or two later.

INTERNAL SPOTTING OR BROWNING OF POTATO TUBERS

The flesh of potato tubers often shows rusty brown or blackish spots or streaks even when the tubers appear sound on the surface. There are various types of such trouble, none of which, however, represents a serious disease in Wisconsin. The more important which have been found here are briefly discussed below.

HOLLOW HEART

This is the familiar condition where overgrown tubers develop a cavity in the center. This is not properly a diseased condition, but is of course objectionable. Closer planting tends to reduce it. The flesh immediately bordering on such a hollow

heart will gradually die and turn brown. This should not, however, be confused with the next.

BLACK HEART

If potato tubers are heated to a little above blood heat for a day or more they will generally begin to die and turn dark at the center. This central portion will soon become purplish black and later may crack open. While this condition may arise in storage pits closely covered by fermenting manure it is most commonly met in car shipments or warehouse storage in winter where a stove is used to keep out frost.

FROST INJURY

If a potato tuber is completely frozen it will, upon thawing, be soft and watery and quickly decay. If, however, it is only slightly frosted the surface layer or isolated spots in this will soften, turn dark, and rot. Bruises or crushing, especially in shipment, will sometimes cause somewhat similar spotting or cracking.

INTERNAL BROWN SPOT

Rusty brown spots from $\frac{1}{8}$ to $\frac{1}{2}$ inch in diameter scattered irregularly through the flesh. Not common or serious in this state. The cause is not known with certainty, but attributed to lack of potash or other food elements. Certainly not parasitic or contagious and not carried from year to year in the seed; therefore, no remedial considerations are called for.

STEM-END BROWNING

Frequently in cutting potato tubers, especially late in winter, they show a slight blackening of the veins penetrating the flesh from the stem end, and occasionally this will follow the veins through the flesh as brown streaks. In most cases this simply indicates a weak tuber which is losing vitality and dying first in these regions. In some cases, however, a similar symptom is produced by the fungous wilt disease which is caused by a parasite carried in the seed and described on a later page. Potatoes showing such symptoms in any marked degree, therefore, should not be used for seed.

PARASITIC DISEASES

COMMON POTATO SCAB

Cause.—Potato scab is caused by a parasitic growth on the surface of the tubers. The spores or germs are carried over winter in the old scab spots, or scattered in the dust from scabby potatoes which may cling to the surface of smooth tubers. The scab parasite persists in the soil many years after a crop of scabby potatoes. It will also pass through the digestive tract of stock fed on scabby potatoes. Morse of the Maine Experiment Station has proved that manure from horses so fed causes



FIGURE 2.—COMMON POTATO SCAB

There are other forms of potato scab and scurf, but this is the commonest in Wisconsin. In some of the blackest spots of this specimen insects have deepened the injury. Seed disinfection and clean soil are the remedies for this disease.

more scab than that of the cow. The scab germ thrives best in an alkaline soil and is checked by acidity. Hence, lime or ashes increase it, and plowing under green crops renders the soil less liable to it.

Minute insects, scab mites, and beetles often invade the scab spots and enlarge and deepen the injury. White grub and wire worm injuries may also be coupled with those of scab, but they have no regular association and are easily distinguishable.

Remedies.—Select smooth seed potatoes; disinfect with formaldehyde (or formalin) and plant on clean soil. Clover sod is

best but any green crop turned under is helpful. Cook scabby potatoes before feeding to stock and do not use fresh manure on potato land or apply lime or ashes. Rotate potatoes with other crops and if scab develops, do not grow potatoes again on that soil for five years or more.

POWDERY SCAB

This is a serious disease, common in Europe and recently introduced from there into portions of Canada and Maine. It is carried on the seed, hence great caution should be exercised in introducing seed potatoes from unknown sources, especially from the East. Growers and dealers, especially with seed stock, should moreover be constantly on the watch for its possible development and in doubtful cases submit samples to the Agricultural Experiment Station for examination. The scab spots of common scab start on the surface whereas those of powdery scab start underneath the skin like blisters which later break open showing the interior filled with a dark powdery mass.

A still more serious disease as yet confined to Europe and Canada is the *black wart*. Therefore *no potatoes should be imported from Europe for any purpose.*

BLACK SCURF

Black scurf often occurs on Wisconsin tubers. It appears as black specks or flakes on the skin like "dirt that won't wash off". It really is not dirt but a fungous growth on the skin of the potato and does little harm under Wisconsin conditions, but farther south and west it may develop on the potato stem and prove more injurious. Hence seed stock for these sections should be as free as practicable from this scurf. Seed disinfection and crop rotation are the methods of control.

SILVER SCURF

Silver scurf is also common but ordinarily does little harm. It appears as dark blotches at the surface of the skin which upon careful examination appear spotted with minute black points which may later show the silvery gray tint that gives the disease its name. The spots increase in storage and by killing the skin cause the potatoes to shrivel earlier and worse than they otherwise would.

The same control measures are recommended as for black scurf but they are not fully effective for either disease.

BLACKLEG

Appearance.—Blackleg is a bacterial disease carried on the seed tubers. There is but little in this state now, but there is evidence that it is being introduced with seed imported from the East. It causes the seed tuber to rot early, sometimes before the sprouts break through the ground, thus giving an irregular stand and weak plants. The rot then spreads up the base of the stem, which turns black and rots as far as the surface of the soil or above. As a result of this, the plant stops growing and the leaves become pale and bend upward giving the plant a sickly, narrow, and spindling appearance. Diseased plants generally die soon without setting any tubers.

The disease is worst in heavy moist soils and in some cases, where it is bad, it may spread from the stem of the tubers, causing a rapid soft rot. Although this disease is not yet serious anywhere in Wisconsin, it occurs widely, and steps should be taken to control it before it becomes common, especially where potatoes are being grown for seed purposes.

Remedy.—This disease, also, has been the subject of careful study by Morse of the Maine Experiment Station, who has shown that it is carried on the seed and that it is controlled by selecting sound seed potatoes and disinfecting them with formaldehyde as for scab. In addition it is well to pull up all diseased plants as soon as detected in the summer so that they will not form tubers which might contaminate the crop.

WILT AND DRY ROT

Occurrence.—Farther south and east potatoes are quite subject to two types of wilt disease and apparently one or both of these may have a foothold in Wisconsin. They are, however, not common and are of minor economic importance except for those growing seed potatoes. The aim should, however, be to recognize them and eradicate them wherever found. The symptoms are so similar that for practical purposes they may be considered together. They are characterized by a wilting and fall-

ing over of the vines of infected hills in midsummer. If tubers are found on these they are liable to show a stem end blackened running for half an inch or more into the flesh, and in storage this may develop into dry rot proceeding from the stem end.

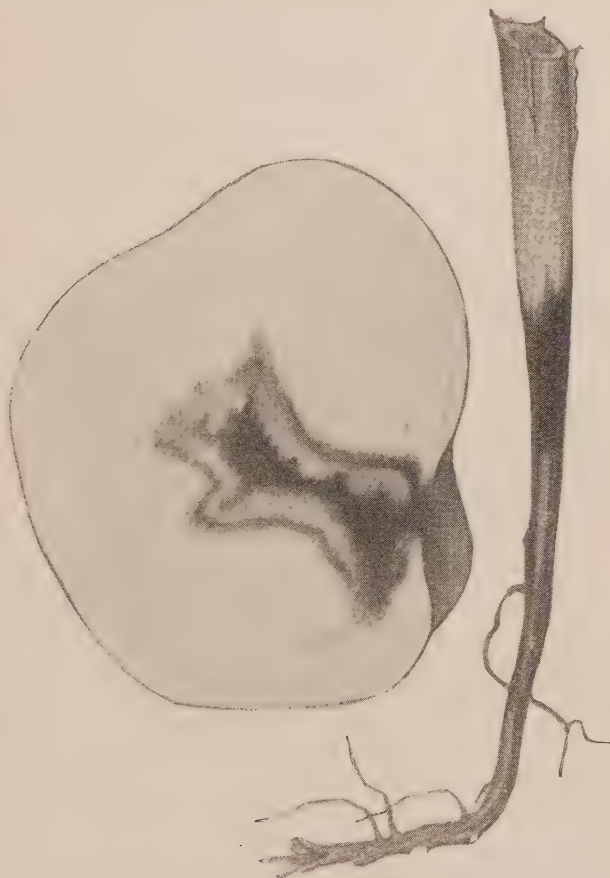


FIGURE 3.—BLACKLEG

The old seed tuber rots, and from this the rot passes to the stem of the young plant which rots to surface of ground or above. If new tubers are set they may show soft rot in field or after digging. As yet, this disease is not common in Wisconsin. Keep it out by removing diseased plants from the field.

Control.—Any suspicious wilting plants should be pulled or dug and destroyed whenever seen during the summer, and seed tubers showing suspicious blackening of the interior, especially at the stem end, should be rejected. In case quick wilting occurs in a field, crop rotation should be practiced, keeping potatoes off the soil for five years or more.



FIGURE 4.—EARLY BLIGHT

Sharply defined dead black spots appear anywhere on leaf. Quite common in Wisconsin potato fields in August and September, especially with later varieties on lighter soils. It can be prevented by spraying.

EARLY BLIGHT

Occurrence.—This is a common fungous disease in Wisconsin which causes black spotting of the leaves in late summer but does not attack the stem or tuber. As these spots enlarge and merge together, the entire leaf may be killed prematurely and so reduce the yield. It is worst on the lighter sandy soils where it may reduce the yield by from 10 to 25 per cent.

Remedy.—Spray with Bordeaux mixture three or four times at intervals of about two weeks during the last half of the summer.

LATE BLIGHT AND ROT

Occurrence.—As indicated by its name, late blight and rot causes the tops to blight in late summer and autumn, and this is followed by rotting of the tubers either in field or in storage. It develops only during moist weather. It is most destructive of all potato diseases under certain conditions. In northern New York, New England, eastern Canada, and northern Europe, it is common in wet seasons especially on the heavier soils and in bad years may destroy 50 per cent or more of the crop. It was this disease which caused the Irish famine of 1845. Fortunately, it is not generally destructive in Wisconsin. It was, however, wide spread throughout the state and caused general blighting of the tops followed by much rotting of the tubers in 1902–1904. Since that time there has been no serious epidemic until 1914 when this disease was again prevalent. The disease is apparently present, in a small way at least, every year in the cooler, moister regions of northern Wisconsin and the extent of its development is simply dependent upon favorable conditions.

Remedy.—Do not knowingly use seed tubers from fields where the blight has occurred. Spraying with Bordeaux mixture as for early blight will control this disease almost perfectly. If the tops are killed by the blight, do not dig the tubers until a week or more after the tops die, then place at once in cool storage to reduce the danger from rot.

POTATO INSECTS¹

It is not the purpose of this circular to list all the potato insects, much less to describe them in detail. Only the commonest will be named in order to point out how they can be controlled when spraying for the diseases described in the preceding pages.

THE COLORADO POTATO BEETLE

The common potato beetles are probably the most generally injurious pests to the potato. The most important treatment, for the season consists of early spraying with arsenical poisons. Thorough control of the first brood hatching on the potato plants, just appearing above the ground, is most important. At this time, a small amount of poison, properly applied, destroys the beetles and young larvae. Late planted, isolated fields often escape serious injury.

Flea-beetles.—These tiny black beetles about the size of a pin-head, often appear in great numbers in midsummer and later. Their attack on leaves soon riddles them with tiny round holes about 1/16 of an inch in diameter. Seriously damaged leaves soon dry out or turn brown at the tips. Potato blight may be distributed by the flea-beetles.

The Bordeaux-arsenical mixture is generally an almost perfect control for flea-beetle injury.

Grasshoppers.—Considerable damage to potato fields is often caused by migrating swarms of grasshoppers living on meadows after harvest. This is particularly true when the weather is hot and dry so that other green food is not available. Not only the potato tips, but often the stems also are seriously injured by grasshoppers.

As with the foregoing insects, the Bordeaux-arsenical spray is quite effective in preventing injury. A better control for grasshoppers is the use of poison bran mash made by stirring 1 pound of Paris green into 25 pounds of dry bran. This mixture should then be moistened with a quart of cheap molasses in two or three gallons of water. By scattering this poisoned mash in

¹ Professor J. G. Sanders of the Department of Economic Entomology has read and revised the statement relative to potato insects and their control.

the path of the grasshoppers or in adjacent fields it is possible to prevent their swarming onto the potato fields.

Tobacco horn worm.—In addition to the above insects, the tobacco horn worm occasionally appears in serious numbers. This has been the case locally during the last two years. It is a green worm the size of one's finger when mature. It is easily controlled by Bordeaux-arsenical sprays, especially if applied in early summer, when the worms are small. If the worms are numerous and large, hand picking may be worth while.

THE CONTROL OF POTATO DISEASES

THE SOIL AND ITS FERTILIZATION

The potato crop is especially sensitive to soil conditions, certain types of soil predisposing it to disease. Certain diseases, as already explained, may be carried in the manure or perpetuated in the soil. Hence the importance of attention to soil and fertilization.

Soil.—A sandy or gravelly clay loam is the best soil for potatoes. In any case avoid heavy wet soils or clays that cannot be properly drained.

Rotation.—Rotate with other crops, planting potatoes not oftener than once in three years.

Fertilization.—Do not use fresh horse manure on potato land, or manure from other animals fed on diseased, uncooked potatoes. Do not use lime or ashes on potato land. Turning under a green crop, like rye or clover sod, is the ideal preparation for potatoes.

SEED SELECTION

Source of seed.—Avoid using seed potatoes from field or crops that suffered badly from diseases known to be carried with the seed, i. e. scab, blackleg, late blight, wilt, and the various types of rot.

Imported seed.—Two very serious European potato diseases threaten to invade America unless great care is exercised. (1.) *Powdery scab* resembles common scab but is even more difficult to control. It is common in Europe and has got into

Eastern Canada and northeastern United States, especially Maine. (2) *Black wart* is widespread in Europe and there held to be the worst of all potato diseases. It has been brought into Newfoundland from Europe. Since both of these diseases are carried in the seed potatoes the United States has established a quarantine regulating the importation of potatoes from Europe and Canada as well as their shipment from Maine. Under these circumstances *no one should attempt to secure seed potatoes from Europe and the greatest caution should be exercised in securing them from the Eastern United States.*

Sorting seed.—Sort carefully just before planting, and use only clean, sound, smooth tubers for seed.

Discolored flesh.—When cutting tubers for planting, a careful lookout should be kept for any showing discolored flesh. If badly discolored, they should be thrown out and not used for seed. If seed is scarce or high-priced and the discoloration is slight, especially if it is closely confined to the stem end, the tuber may be used, provided such discolored part is cut off and rejected.

DISINFECTION OF SEED POTATOES

The germs of the scab and blackleg diseases should be destroyed. They may be carried on the surface of tubers taken from a diseased crop, even though these tubers are themselves smooth and healthy.

All seed tubers from fields not known to be free from disease, and from unknown sources, especially if from the East, should be disinfected. In any case, it is a simple, inexpensive and harmless precautionary measure. There are two standard solutions, either of which may be used.

Formaldehyde or formalin.—Soak seed potatoes in a solution of one pint of formalin (40 per cent formaldehyde) in 30 gallons of water. The same solution may be used repeatedly without deterioration.

Corrosive sublimate—also called mercuric chloride—dissolved at the rate of 1 part to 1,000 by weight in water is as effective as the formalin solution but has the danger of being very poisonous. The sublimate can be secured either in tablet form or in bulk. Dissolve a tablet in a quart of water or an ounce in 30 quarts of water and soak the potatoes two hours.

These solutions are about equally effective against scab and blackleg and since the formaldehyde is cheaper and safer to use it is generally preferable. The corrosive sublimate has recently been shown by experiment at the Geneva, New York, Experiment Station to be more effective against black scurf disease.

After disinfection the tubers may be planted at once, or dried and stored. In any case, care should be taken not to reinfect them by placing in old sacks or bins.

Fumigation.—Formaldehyde gas has sometimes been used to disinfect tubers but is so liable to injure them that it cannot be generally recommended. On the other hand it offers the simplest and most effective method of disinfecting potato warehouses or storage rooms if they can be tightly closed. The method is as follows: Calculate the cubic contents of the room and for each 1,000 cubic feet, use 23 ounces of potassium permanganate and three pints of formalin. Place the potassium permanganate in a shallow layer in the bottom of a pail or tub in the middle of the room at least three feet from the nearest potatoes, none of which should stand immediately above it, and pour the formalin over the permanganate. Quickly close the room air-tight and leave it closed twenty-four hours or longer. These fumes are irritating to the eyes and nostrils, but not actually poisonous, so one runs no serious risk in the operation.

SPRAYING POTATOES

In spraying plants, as in most other matters of plant culture, judgment based on experience is necessary for the best success. The following directions are written with the idea of giving any practical potato grower such advice as will enable him safely to begin spraying operations. Careful study of his own conditions will then soon enable him to adapt the methods and dates of spraying to his own particular needs.

Early applications.—As soon as the eggs of the first "potato bug" (Colorado beetle) hatch, make one application of an arsenical poison alone. *Promptness in early spraying is the thing of chief importance.* The poison may be applied either wet or dry. The standard treatment is, Paris green applied either in water or dry and diluted with air-slaked lime or land plaster, (gypsum) using about one or two pounds of the poison per acre. Arsenical poisoning of the potato leaves frequently

follows the use of Paris green owing to the soluble arsenic contained in it. To avoid this, neutralize this soluble arsenic with lime. If used dry, this may be done by mixing with air slaked lime; if to be applied as a spray in water, add one pound of lime for each pound of Paris green to be used. In recent years, other arsenical poisons have been used more or less as substitutes for Paris green especially lead arsenate. Three pounds in 50 gallons of water, applied with spray pump is more adhesive, but slower in its action on insects than Paris green.

If the bugs are especially troublesome, a second application of the arsenical poison may be necessary. Otherwise, the later insects are controlled by the following sprays.

Later applications of Bordeaux mixture.—(For insects and blights.) About two weeks later, i. e. beginning about midsummer, spray with Bordeaux mixture made as follows: Copper sulphate 5 pounds, fresh stone lime 5 pounds, water 50 gallons, and Paris green 2 or 3 pounds or lead arsenate 3 pounds.

MAKING BORDEAUX MIXTURE

The best way to make one barrel of this mixture is as follows: Slake the lime and dissolve the copper sulphate in water in separate dishes. Strain the lime water into the barrel and add water to fill the barrel about half full. Dilute the sulphate solution with several pailfuls of water and strain this into the barrel, stirring promptly and thoroughly and adding more water as needed to fill the barrel. Add the arsenical poison and use at once. The important point to remember is that both lime and sulphate solution should be diluted with water before combining, and the mixture stirred. If this mixture is allowed to stand long, it settles to the bottom and is thereafter less effective and more likely to clog the nozzles.

If used in sufficiently large quantities stock mixtures should be made up in advance. Use one pound of copper sulphate per gallon of water and mix the lime and water at the same rate in a separate vessel. Mix in sufficient quantity for a whole season's spraying, keep separate until ready to spray, and then use one gallon of the copper sulphate for each pound of sulphate desired and one gallon of the other mixture for each pound of lime desired. For example, in making the 5-5-50 mixture just recommended for insects and blight, mix five gallons of each of the

two stock mixtures and dilute with sufficient water to make 50 gallons of spray. If much spray is to be made, a mixing outfit should be arranged on an elevated platform, provided with a pump or other water supply and barrels to hold these stock solutions.

This application of Bordeaux-arsenical mixture should be repeated about once in two weeks through midsummer according to need for control of blight and insects. In case the crop is liable to suffer severely from either early blight or late blight, it will pay to continue spraying in this same way through the late summer.

"ROGUE" POTATO FIELDS

Every one growing potatoes primarily for seed purposes should go over his field at least twice during midsummer preferably about blossoming time and "rogue" the crop. If many plants have to be removed it is well to go over the ground a second time a week or two later. This will, of course, be primarily for the purpose of pulling out all plants not true to varietal type. At the same time a sharp watch should be kept for any tops showing symptoms of the leaf-roll, blackleg, or wilt diseases. Any such should be pulled to prevent tuber formation. If one is merely growing his own seed, it may ordinarily suffice to thus carefully "rogue" only a portion of the field from which the seed stock may then be taken.

